

In the Claims

This listing of claims will replace all prior versions and listings of claims in the application:

1 1. (Original) A computer implemented method of approximating
2 a gray scale tone with a more limited range image producer,
3 comprising the steps of:

4 associating one of a plurality of tone curves with each pixel
5 of a screening matrix;

6 generating polynomial coefficients of a curve approximating
7 each of said plurality of tone curves;

8 storing said polynomial coefficients approximating each of
9 said plurality of tone curves in a look-up table;

10 mapping each pixel of an image to a corresponding pixel of
11 said screening matrix;

12 for each pixel of said image

13 recalling said polynomial coefficients approximating said
14 tone curve associated with said pixel of said screening matrix
15 mapped to said pixel, and

16 computing a pixel output value from a pixel input value
17 of said pixel and said recalled polynomial coefficients.

1 2. (Original) The computer implemented method of claim 1,
2 wherein:

3 said polynomial is a third degree polynomial of the form

4
$$y = ((a * x + b) * x + c) * x$$

5 where: y is the pixel output value to be computer; a is a first
6 coefficient; b is a second coefficient; c is a third coefficient;
7 and x is the pixel input value.

3. (Canceled)

1 4. (Original) The computer implemented method of claim 2,
2 wherein:

3 said step of computing a pixel output value computes a first
4 pixel output value and a second pixel output value by sequentially

5 (1) multiplying a first pixel input value by a first
6 coefficient corresponding to said first pixel producing a
7 first intermediate value,

8 (2) simultaneously multiplying a second pixel input value
9 by a first coefficient corresponding to said second pixel
10 producing a second intermediate value, and adding a second

11 coefficient corresponding to said first pixel to said first
12 intermediate value producing a third intermediate value,

13 (3) simultaneously multiplying said third intermediate
14 value by said first pixel input value producing a fourth
15 intermediate value, and adding a second coefficient
16 corresponding to said second pixel to said second intermediate
17 value producing a fifth intermediate value,

18 (4) simultaneously multiplying said fifth intermediate
19 value by said second pixel input value producing a sixth
20 intermediate value, and adding said third coefficient
21 corresponding to said first pixel to said fourth intermediate
22 value producing a seventh intermediate value,

23 (5) simultaneously multiplying said seventh intermediate
24 value by said first pixel input value producing said first
25 pixel output value, and adding said third coefficient
26 corresponding to said second pixel to said sixth intermediate
27 value producing an eighth intermediate value, and

28 (6) multiplying said eighth intermediate value by said
29 second pixel input value producing said second pixel output
30 value.

1 5. (Original) The computer implemented method of claim 4,
2 wherein:

3 said pixel input values are represented in a fixed point
4 representation of 8 bits including zero integer bits and eight
5 fractional bits;

6 said first, second and third coefficients corresponding to
7 each tone curve are represented in a fixed point representation of
8 16 bits including four integer bits and twelve fractional bits;

9 said step of adding said second coefficient corresponding to
10 said first pixel to said first intermediate value producing a third
11 intermediate value includes right shifting said first intermediate
12 value 8 bits prior to addition;

13 said step of adding said second coefficient corresponding to
14 said second pixel to said second intermediate value producing a
15 fifth intermediate value includes right shifting said second
16 intermediate value by 8 bits prior to addition;

17 said step of adding said third coefficient corresponding to
18 said first pixel to said fourth intermediate value producing a
19 seventh intermediate value includes right shifting said fourth
20 intermediate value by 8 bits prior to addition; and

21 said step of adding said third coefficient corresponding to
22 said second pixel to said sixth intermediate value producing an
23 eighth intermediate value includes right shifting said sixth
24 intermediate value by 8 bits prior to addition.

1 6. (Original) A printer comprising:

2 a transceiver adapted for bidirectional communication with a
3 communications channel;

4 a memory;

5 a print engine adapted for placing color dots on a printed
6 page according to received image data and control signals; and

7 a programmable data processor connected to said transceiver,
8 said memory and said print engine, said programmable data processor
9 programmed to:

10 receive print data corresponding to pages to be printed
11 from the communications channel via said transceiver;

12 convert said print data into image data and control
13 signals for supply to said print engine for printing a
14 corresponding page, said conversion including approximating a
15 gray scale tone with a more limited range print engine by

16 storing polynomial coefficients approximating each
17 of a plurality of tone curves in a look-up table,

18 mapping each pixel of an image to a corresponding
19 pixel of a screening matrix;

20 for each pixel of said image

21 recalling a corresponding set of polynomial
22 coefficients approximating a tone curve associated
23 with said pixel of said screening matrix mapped to
24 said pixel, and

25 computing a pixel output value from a pixel
26 input value of said pixel and said recalled
27 polynomial coefficients.

1 7. (Original) The printer of claim 6, wherein:

2 said programmable data processor including a hardware
3 multiplier and an arithmetic logic unit, said programmable data
4 processor being further programmed to compute said pixel output
5 value by

6 multiplying said pixel input value by said first
7 coefficient in said hardware multiplier producing a first
8 intermediate value,

9 adding said second coefficient to said first intermediate
10 value in said arithmetic logic unit producing a second
11 intermediate value,
12 multiplying said second intermediate value by said pixel
13 input value in said hardware multiplier producing a third
14 intermediate value,
15 adding said third coefficient to said third intermediate
16 value in said arithmetic logic unit producing a fourth
17 intermediate value, and
18 multiplying said fourth intermediate value by said pixel
19 input value in said hardware multiplier producing said pixel
20 output value.

1 8. (Original) The printer of claim 6, wherein:
2 said programmable data processor including a hardware
3 multiplier and an arithmetic logic unit, said programmable data
4 processor being further programmed to compute said pixel output
5 value by
6 (1) multiplying a first pixel input value by a first
7 coefficient corresponding to said first pixel in said hardware
8 multiplier producing a first intermediate value,
9 (2) simultaneously multiplying a second pixel input value
10 by a first coefficient corresponding to said second pixel in
11 said hardware multiplier producing a second intermediate
12 value, and adding a second coefficient corresponding to said
13 first pixel to said first intermediate value in said
14 arithmetic logic unit producing a third intermediate value,
15 (3) simultaneously multiplying said third intermediate
16 value by said first pixel input value in said hardware
17 multiplier producing a fourth intermediate value, and adding a
18 second coefficient corresponding to said second pixel to said

19 second intermediate value in said arithmetic logic unit
20 producing a fifth intermediate value,

21 (4) simultaneously multiplying said fifth intermediate
22 value by said second pixel input value in said hardware
23 multiplier producing a sixth intermediate value, and adding
24 said third coefficient corresponding to said first pixel to
25 said fourth intermediate value in said arithmetic logic unit
26 producing a seventh intermediate value,

27 (5) simultaneously multiplying said seventh intermediate
28 value by said first pixel input value in said hardware
29 multiplier producing said first pixel output value, and adding
30 said third coefficient corresponding to said second pixel to
31 said sixth intermediate value in said arithmetic logic unit
32 producing an eighth intermediate value, and

33 (6) multiplying said eighth intermediate value by said
34 second pixel input value in said hardware multiplier producing
35 said second pixel output value.

1 9. (Original) The printer of claim 8, wherein:

2 said programmable data processor further including a shifter
3 at one input to said arithmetic logic unit, said programmable data
4 processor being further programmed to compute said pixel output
5 value by

6 right shifting said first intermediate value 8 bits prior
7 to addition;

8 right shifting said second intermediate value by 8 bits
9 prior to addition;

10 right shifting said fourth intermediate value by 8 bits
11 prior to addition; and

12 right shifting said sixth intermediate value by 8 bits prior to
13 addition.